NC3A Simulation Support for Theatre Missile Defence Operations in NATO Exercise Cannon Cloud 2002 (CC02)

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ABSTRACT

This paper discusses modeling and simulation methods to be employed by the NC3A to support Theatre Missile Defence (TMD) operations in the upcoming Supreme Headquarters Allied Powers Europe (SHAPE) exercise Cannon Cloud 02 (CC02). The TMD operations are but a small part of a large, multi-corps, multi-CAOC (combined air operations centre) computer-assisted exercise (CAX) using the Joint Theatre Level Simulation (JTLS) operated at the United States Air Force – Europe (USAFE) Warrior Preparation Center (WPC) in Einsiedlerhof, Germany. The challenge for this exercise was determining how to integrate the detailed, entity-level simulations necessary to support active defence, passive defence, and time-critical and time-sensitive targeting functions of TMD operations with the aggregated movements of the larger JTLS environment.

The approach taken to the multi-resolution modeling problem was threefold. First, high-level architecture (HLA) methods were used to pass Tactical Ballistic Missile (TBM) events between JTLS, the Extended Air Defence Simulation (EADSIM) and NATO's Shared Early Warning (SEW) system to allow simulation interoperability. Next, in order to synchronize the detailed movements of TBM units in JTLS and the entity-level simulation Integrated Target Environment Simulation Tool (ITEST), identical movements were created for JTLS units. Lastly, civilian background traffic not represented in JTLS was geographically separated from the combat area. Discussions of this simulation integration are included in this paper, but owing to the

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exercise schedule, the results of the effort to minimize the multi-resolution modeling problem will be reported at a later date.

To integrate the simulations for CCO2, cooperation was fostered between two divisions of the NC3A, Allied Air Forces North (AIRNORTH), the Royal Netherlands Air Force (RNLAF), TNO (a Dutch organization for applied scientific research), and the seven-nation Coalition Aerial Surveillance and Reconnaissance (CAESAR) Project.

INTRODUCTION

NATO C3 Agency

The NATO Consultation, Command and Control Agency (NC3A) is located in two facilities: one in The Hague, Netherlands, and the other in Brussels, Belgium. The NC3A was formed in 1996 by the amalgamation of the former SHAPE Technical Centre (STC) and the NATO Communications and Information Systems Agency (NACISA); the NC3A is chartered to provide unbiased scientific advice and assistance to NATO military and political authorities. Additionally, the Agency plays a major role in developing, procuring and implementing cost-effective systems capabilities to support the political consultation and military command and control functions of NATO. The mission of the NC3A is defined in the charter of the NATO C3 Organization (NC3O)[1].

The mission of the NC3A is to:

- Perform central planning, systems integration, design, systems engineering, technical support and configuration control for NATO C3 systems and installations.
- Provide scientific and technical advice and support to the Strategic Commands and other customers on matters pertaining to operations research, surveillance, air command and control including theatre missile defence, electronic warfare and airborne early warning and control, and communications and information systems, including technical support for exercises and for unforeseen operations assigned to the NATO Military Authorities by the North Atlantic Council's Defence Planning Committee.
- Perform technical policy and standardization work in support of the NATO C3 Board and its substructure towards the development and maintenance of the NATO Interoperability Framework.
- Procure and implement projects assigned to it.

The organization of the NC3A consists of a General Management office, Executive Staff, a Director of Operations, and six Divisions. The Theatre Missile Defence (TMD) work discussed in this paper was performed by the Command and Control Systems Division, Command and Control Concepts and Architecture Branch[2], which serves as NATO's Centre of Excellence for TMD Battle Management Command and Control and Air-Ground Surveillance and Reconnaissance (AGSR). The overall exercise is managed by the Exercises, Design and Scenario Development Branch of the Operations Research and Functional Services (ORFS) Division.

[1] NC3A website http://www.nc3a.nato.int/ pages/frameset_org.html.

[2] Branch website http://www.nc3a.nato.int/ pages/ccsdiv/ccb/ccb_main.htm.

Operations Research and Functional Services (ORFS) Division

The mission of the Operations Research and Functional Services Division is to conduct scientific and technical analysis for SHAPE and its subordinate commands on a wide range of military operational and planning issues. These analyses range from broad studies of military concepts such as those relating to the new missions of SACEUR, to detailed examination of the performance of military units and support systems.

Exercises, Design and Scenario Development Branch

The mission of NC3A's exercise branch is to support NATO's Allied Command Europe (ACE) in the specification, development, implementation and evolution of a training and exercise organization. This organization makes use of the most advanced methods and tools available to perform its tasks of individual and collective training and exercise. Hence there is emphasis on assistance by automated systems in the preparation, conduct, observation and analysis of training events.

An evolutionary methodology of systems development is applied that relies heavily on user participation and experimentation. Methods of organization and work and supporting tools are developed and tested in a laboratory environment. Sufficiently successful prototype capabilities are subsequently applied during exercises.

This phase of field testing is essential in evaluating capabilities with a broad user set under realistic performance conditions. The empirical data that can be gathered in this manner forms the basis for the acquisition process of capabilities that will meet user requirements and will be able to continue to evolve. The incorporation of the TMD simulations represents an example of this policy. Further discussions are presented below under 'The Way Ahead'.

Command and Control Systems Division (CCSD)

The mission of the CCSD is to support overall system-level architectures, concepts and implementation of command and control (C2), battlespace management (BM), and intelligence, surveillance and reconnaissance (ISR) capabilities for air, sea, land, and joint operations, mainly at the operational and tactical levels. The Division consists of a Management and Project Support element, and five scientific branches.

Command and Control Concepts and Architecture Branch

The C2 Concepts and Architecture Branch consists of eight scientists and three scientific support staff, augmented at times by technical experts supplied by nations in order to support the work of the Branch. On behalf of SHAPE, this Branch is responsible for a number of activities, including:

- Definition of requirements for NATO's emerging air-ground surveillance and reconnaissance (AGSR) capabilities;
- Technical management of the Coalition Aerial Surveillance and Reconnaissance (CAESAR) activity;
- Definition of NATO's Theatre Missile Defence Battle Management Command, Control and Communications requirements.

In addition, on behalf of the Conference of National Armaments Directors, the Branch provides support to the NATO active Layered Theatre Ballistic Missile Feasibility Study.

The role of the Command and Control Concepts and Architecture Branch in the exercise is to provide the hardware, software and communications capability required to enable detailed simulation of TMD activity of suitable fidelity such that the training objectives of the Joint Theatre Missile Defence Cell (JTMDC) could be achieved. This task is further complicated by the integration with the aggregate Joint Theatre Level Simulation (JTLS), which provides the overall environment for the exercise. Figure 1 depicts the architecture established for the exercise.

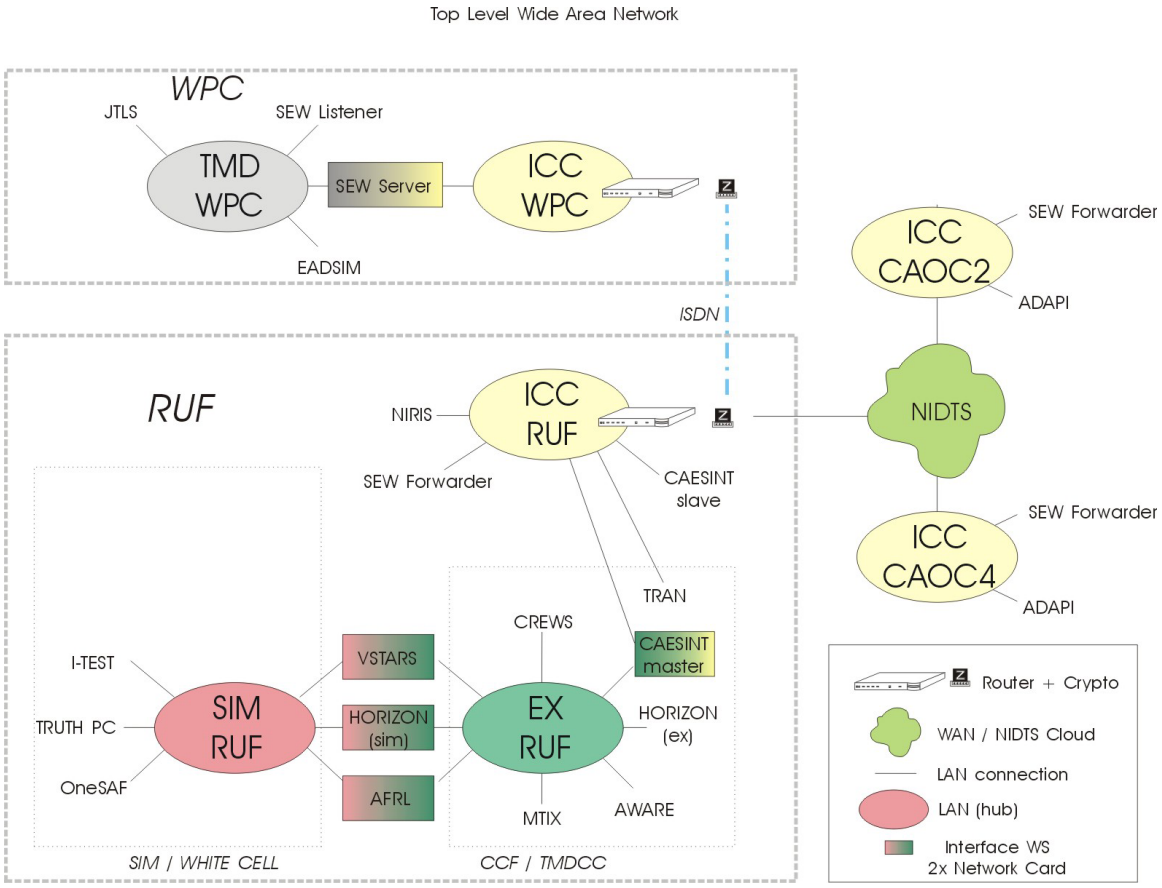

Figure 1: Exercise Network Architecture.

CANNON CLOUD 2002 OVERVIEW

CC02 is a large, multi-corps, multi-CAOC, computer-assisted exercise (CAX) that will be conducted at the USAF Europe (USAFE) Warrior Preparation Center (WPC) in Einsiedlerhof, Germany. The primary purpose of CC02 is to support higher echelon operational training for coalition forces in a large-scale, high-intensity conflict using the Joint Theatre Level Simulation (JTLS), which is an aggregate simulation that has served as the SHAPE-approved CAX simulation since 1995.

The scenario to be employed uses actual northern European terrain with fictitious national boundaries (see Figure 2). The Tactical Ballistic Missile (TBM) threats are operated by the coalition of Oliveland and Orania against the southern region of Montrena.

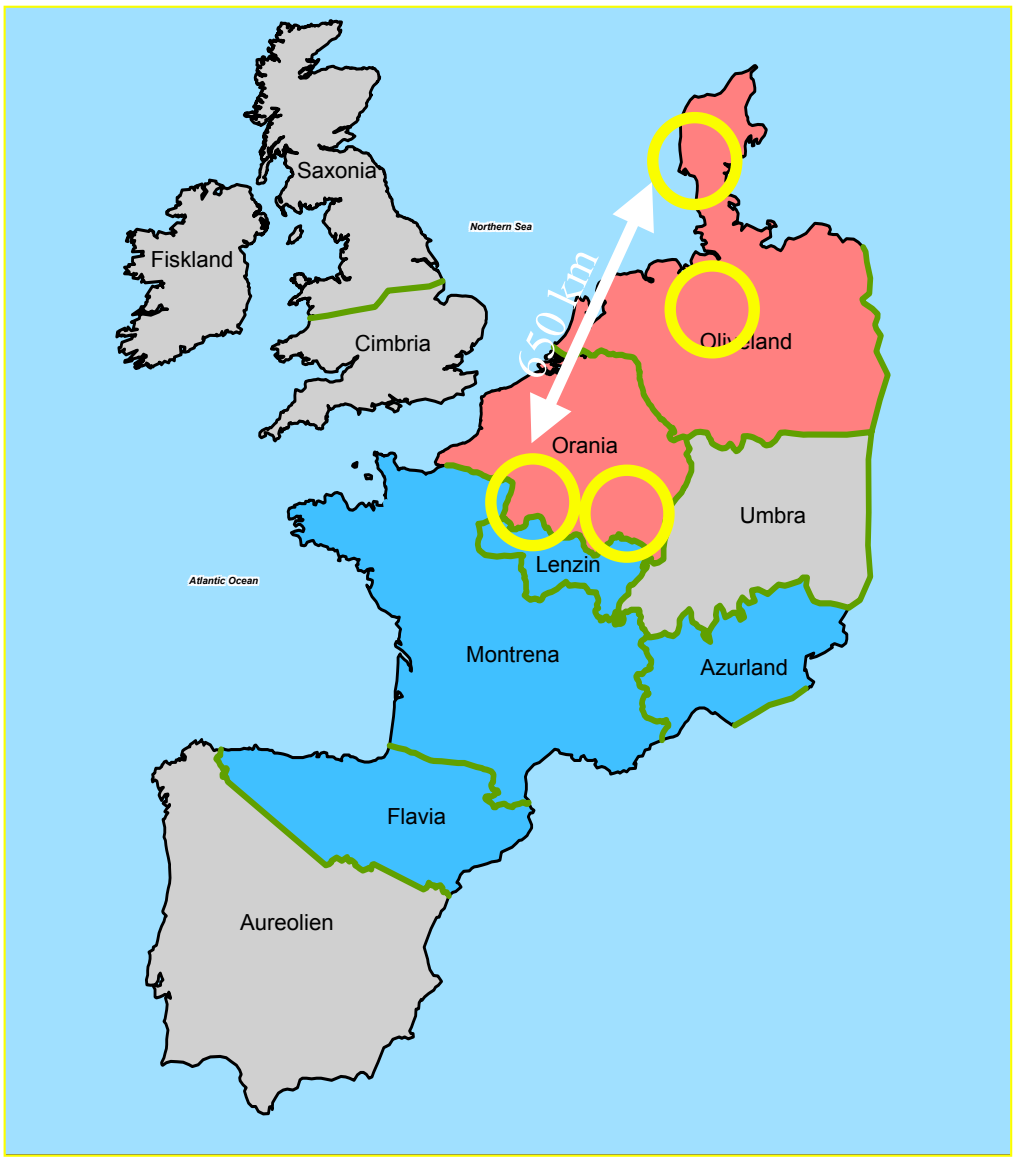

Figure 2: Cannon Cloud Scenario with TBM Areas of Operation.

The Joint Theatre Missile Defence Cell (JTMDC) will act as the hub of the Battle Management / Command, Control, Communications, Computers and Intelligence (BMC4I) capabilities required to coordinate conventional counter-force (CCF) and passive defence (PD) operations, and integrate these elements into the overall combat operations (see Figure 3).

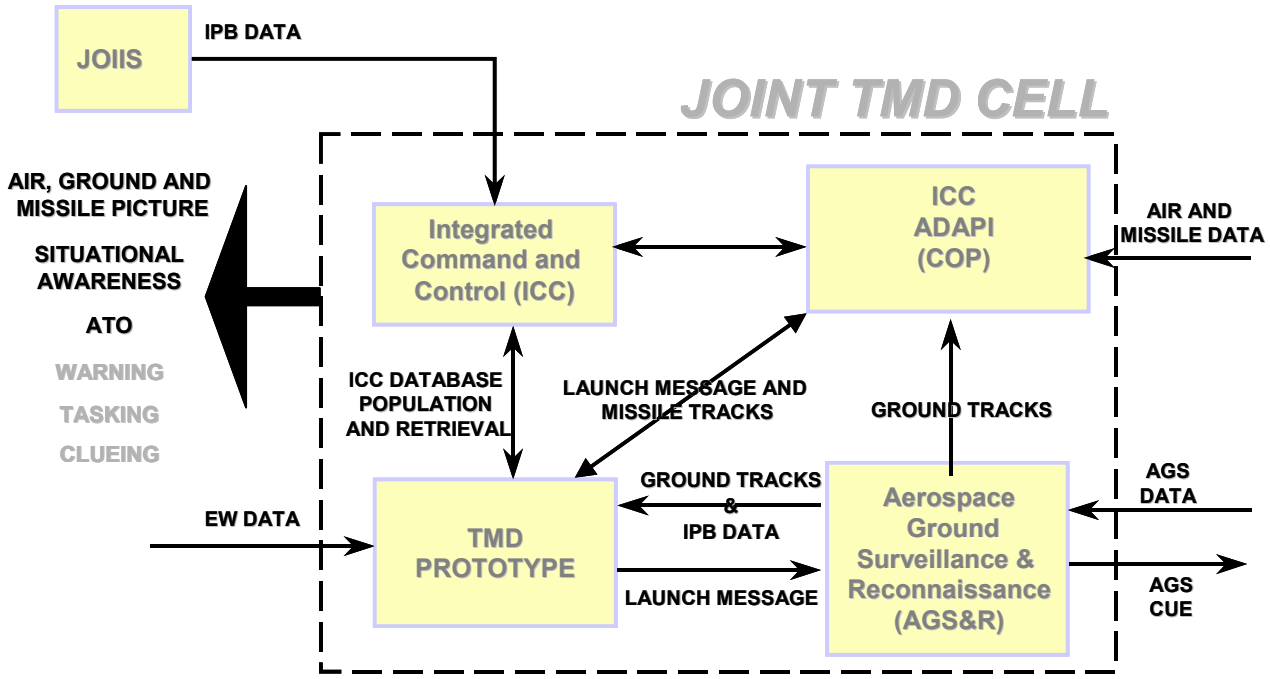

Figure 3: Joint Theatre Missile Defence Cell.

The objective of the TMD segment of Cannon Cloud is to provide a realistic TBM threat. The mission of the JTMDC is to protect NATO forces from TBM attack by conducting CCF operations against threat coalitions to ensure that threat TBM infrastructure and support systems can be destroyed prior to TBM launch.

JTLS Installation at the Warrior Preparation Center

The CC02 technical and exercise control nexus is at the WPC where over 200 workstations will be deployed running the JTLS simulation. Response cells for Corps and CAOC battle staffs operating in the field are colocated at the WPC with the exercise-directing staff and cells representing other forces and neutral entities depicted in the scenario. The Rupertsweiller Underground Facility (RUF), acting in perhaps its last NATO exercise, will serve as AIRNORTH's wartime command centre with exercise data fed to its command systems through the NATO communications infrastructure. There is no JTLS linkage to the RUF.

The Four Pillars of NATO TMD Doctrine

The four pillars of NATO's TMD doctrine are: passive defence, active defence, conventional counter-force (CCF) and battle management, command, control, communications and intelligence (BMC3I). Each of these elements of TMD doctrine will be employed in the exercise.

Passive Defence

Passive defence will be provided by the NATO Shared Early Warning (SEW) system. For the exercise, the SEW injector tool will create a launch event initiated by JTLS using a high-level architecture (HLA) listener. The launch warning data will then be forwarded to the SHAPE server via the secure CRONOS wide-area network (WAN).

Active Defence

Active defence will be provided at the WPC in conjunction with the Dutch/German combined exercise Constructive Optic Windmill (COW). The Royal Netherlands Air Force (RNLAF) will operate Patriot PAC-3, the German Air Force (GAF) will operate Patriot PAC-2 and the Royal Netherlands Navy (RNLN) will operate the Air Defence and Command Frigate (ADCF). The Extended Air Defence Simulation (EADSIM), provided by TNO-FEL, will provide simulations of both the TBM missile fly-out and the interceptor at the entity level. EADSIM, like the SEW injector, is linked to JTLS using HLA but with a more robust interface including missile inventory reduction and the resulting intercept result fed back into JTLS.

Conventional Counter-Force

Conventional counter-force operations require a representation of the radar-based Alliance Ground Surveillance (AGS) systems. The seven-nation Coalition Arial Surveillance and Reconnaissance (CAESAR) project provides simulations of the Canadian RADARSAT II, the Italian CRESO MTI helicopter, the French HORIZON MTI helicopter and the US Global Hawk UAV, Joint STARS, Predator UAV, P-3 ('Hairy Buffalo'), and U2 ASARS 2. These surveillance systems will search for the launch systems and their associated infrastructure using Ground Moving Target Indication (GMTI) and Synthetic Aperture Radar (SAR) modes.

To support the level of detail required for the sensor simulations, the rear-echelon movements of TBM components, unit headquarters, and civilian traffic must be represented on an individual vehicle basis. Additionally, the AGS exploitation systems are becoming sophisticated enough in their ability to generate tracks that realistic movement and behavior must be reflected in the movements of the individual vehicles.

Entity-level simulation capability will be operated at the RUF using Trident Systems' Integrated Target Environment Simulation Tool (ITEST). Scripted movements were generated that allow vehicle-level movements that reflect threat concept of operations (CONOPS). These scripts were also ported to the JTLS simulation as high-resolution units (HRU) so that identical movements will be portrayed in the overall exercise.

Battle Management, Command, Control, Communications and Intelligence (BMC3I)

The CAESAR project provides the battle staff of the JTMDC with advanced MTI and SAR exploitation systems used for target development. The dissemination of the exploited AGS data to the wider command and control information systems is performed through the transmission of Link-16 J-series messages (see Table 1) via the NC3A Interoperable Recognized Air Picture (RAP) Information System (NIRIS). CAOC-2 (in De Peel, NL) and CAOC-4 (in Messtten, GE) will be able to display ground track information on Integrated Command and Control (ICC) terminals operating the ADAPI (air defence air picture) software.

Table 1: Link-16 Messages Disseminated Using NIRIS

Message	Description
J2.2	Air Precision Point Location Indication (PPLI)
J2.5	Ground Precision Point Location Indication (PPLI)
J3.0	Reference Point
J3.2	Air Track
J3.5	Ground Track

NC3A and its sponsor SHAPE OPS have developed an information system that disseminates the RAP to various users, converts data between formats, provides record and playback capabilities, and provides specialized hardware components for security filtering and protocol matching.

NIRIS consists of both hardware and software components that can be mixed and matched to provide solutions to real-time data interfacing, distribution, and display of maritime, ground, air tactical, and TMD data.

The aim of NIRIS is to acquire, distribute and transform tactical data produced by radars and assembled by sensor fusion posts; tactical data contains near-real-time position information, airplane ID and information from the airplane transponders. The combination of several tactical data feeds can be displayed on a map and constitutes the RAP for the countries that are part of the network. For CC02, ground track information has been added to the NIRIS Link-16 message library allowing GMTI data to be displayed on ICC terminals using the ADAPI software.

INTEGRATION OF SIMULATIONS USING HLA

Simulation interoperability is currently perceived as the most cost-effective method of enhancing exercise environments. In particular, combining proven exercise simulations to meet emerging exercise requirements allows user confidence to be maintained and reduces technical as well as exercise operational risk.

However it must be recognized that this approach requires greater emphasis on and resources for interoperability protocol management and evolution as well as for federation compliance testing. It also needs to be understood that interoperability in a multinational context requires a substantial and sustained commitment by the participating nations and institutions.

The first step in the exercise planning process was to develop an architecture for the integration of the systems that would meet the requirements of the exercise and minimize the risk associated with the multi-resolution modeling problem. After several iterations the final architecture was developed (Figure 4).

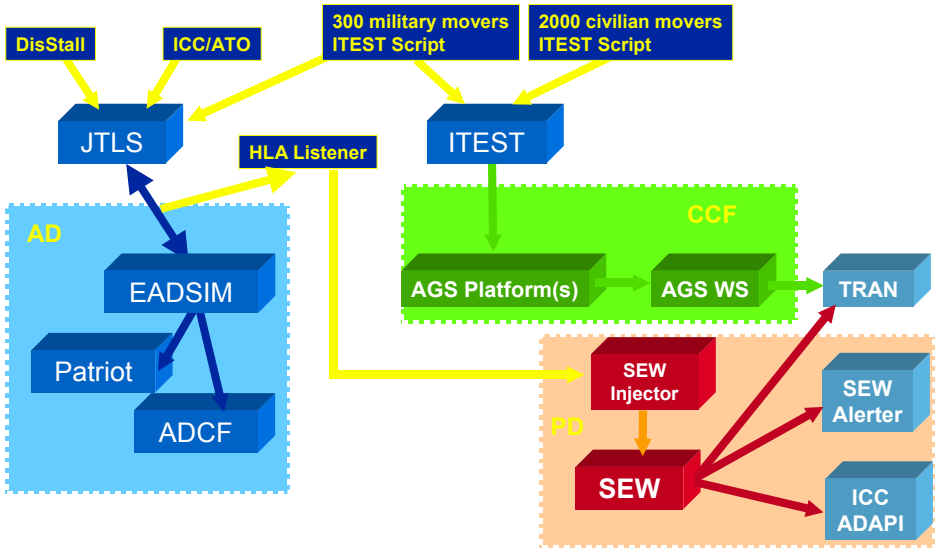

Figure 4: Interoperable Simulation Architecture.

The operation of aggregate and entity-level simulations is problematic and the topic of a great deal of research within the simulation community. NC3A has chosen the geographic separation technique to limit the conflict associated with multi-resolution simulation. Operationally this is appealing in that the TBM threat generally operates towards the rear area and the overlap area of coverage is minimized.

High Level Architecture (HLA) Testbed

In order to facilitate the integration of JTLS, EADSIM, SEW and the various AGS simulations, an HLA testbed was established in the NATO Alliance Ground Surveillance (AGS) Capability Testbed NACT (see Figure 5). This facility allowed the development and testing of the HLA components necessary to integrate the different simulations. The computer-aided software engineering (CASE) tool kit used was AEgis Technology Inc.'s HLA Labworks©.

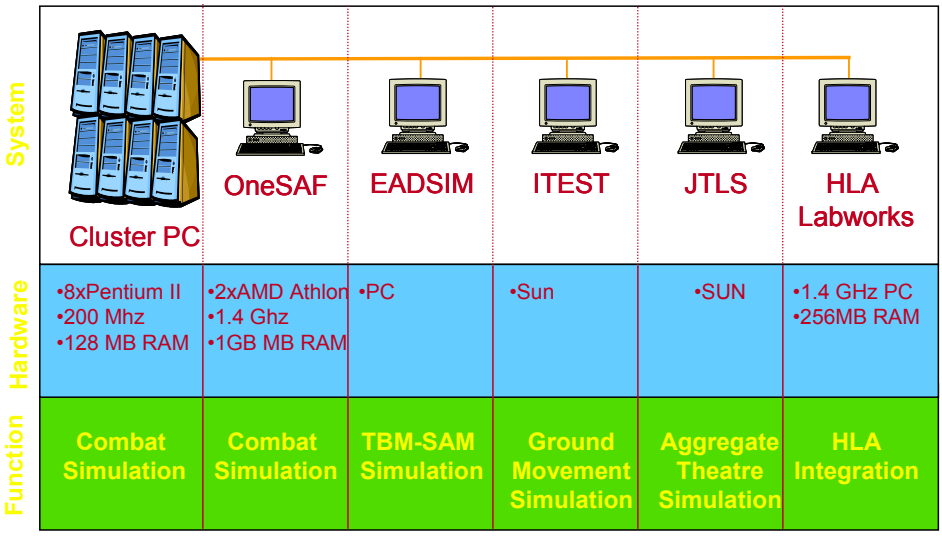

Figure 5: NC3A High-Level Architecture Testbed.

Active Defence

The Dutch national exercise Constructive Optic Windmill (COW) contributed the active defence portion of TMD operations for CC02. TNO-FEL, under contract from the RNLAF, developed the federation that allows simulation events to be passed between JTLS and EADSIM. JTLS issues the TBM launch command and EADSIM flies the missile. The RNLAF, the RNLN and the GAF will operate EADSIM to launch Patriot and SM-2 interceptors and the results of these engagements will be forwarded to JTLS to both update the interceptor inventories and implement the results of the engagement. Furthermore, satellites are simulated to produce the required launch-point prediction (LPP) and impact-point prediction (IPP) for the SEW system.

The development of the JTLS-EADSIM federation required more resources than were planned for. Despite previous integration efforts earlier in the year it appeared that the different implementations of HLA in the two simulations caused instability that was difficult to track down. EADSIM has the Agile FOM (federate object model) embedded within the software whereas JTLS appears to have been designed for a different, more homogeneous use of HLA. The federation was stabilized but it should be noted that the integration of disparate HLA implementations may present unforeseen challenges.

Passive Defence

NATO currently operates the Shared Early Warning (SEW) system, which receives satellite warnings of missile launches within NATO's area of concern. In past exercises[3] the simulated launches originated from the US North American Aerospace Defense (NORAD) system and the SEW data paths were used. For CC02 these are not being used. Instead an HLA listener was developed that detects the JTLS launch commands sent to EADSIM. This information is then fed into the SEW system using the SEW alert tool, which emulates the data from space-based warning systems.

The HLA listener was developed relatively quickly but the implementation revealed a minor problem within EADSIM that required a work-around. The identification tag used to link the missile to the launch event was mistakenly assigned the identification of the launcher, not the missile. This was resolved by waiting for subsequent entity state messages coming out of EADSIM. The time delay incurred waiting for the subsequent message with the appropriate data allows realistic simulation of the data dissemination process.

Multi-Resolution Modeling (MRM) Issues for the Conventional Counter-Force Mission

The conventional counter-force mission presents a challenge to the simulation architecture in that the sensor simulations providing the AGS coverage are engineering-level models requiring detailed entity-level movement, digital terrain elevation and features data. In order to represent the same TBM infrastructure movements in JTLS that the AGS sensors see, HRU scripts were generated that have individual launcher movements that are synchronized with the AGS simulation (see Figures 6 & 7).

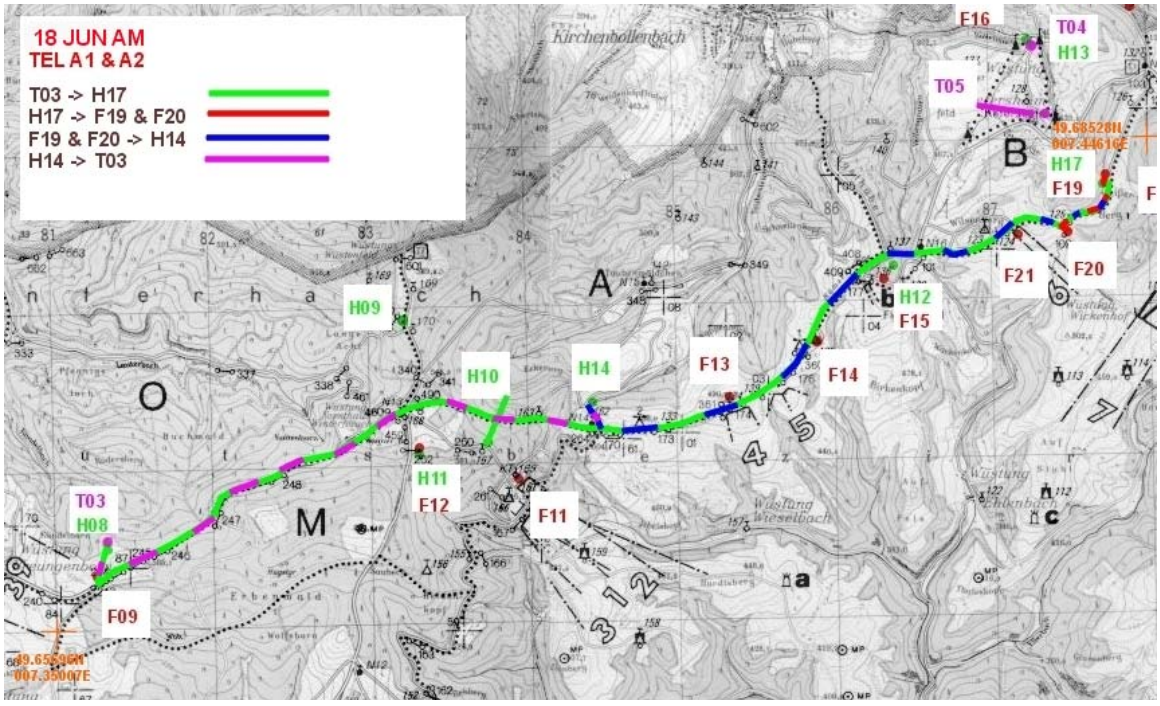

Figure 6: Detailed TBM Force Movements Used for AGS Simulations.

[3] 'NC3A Simulation Support for NATO Exercise Clean Hunter 2001', David Taylor, paper presented at CCRTS in Monterey, California, June 2002.

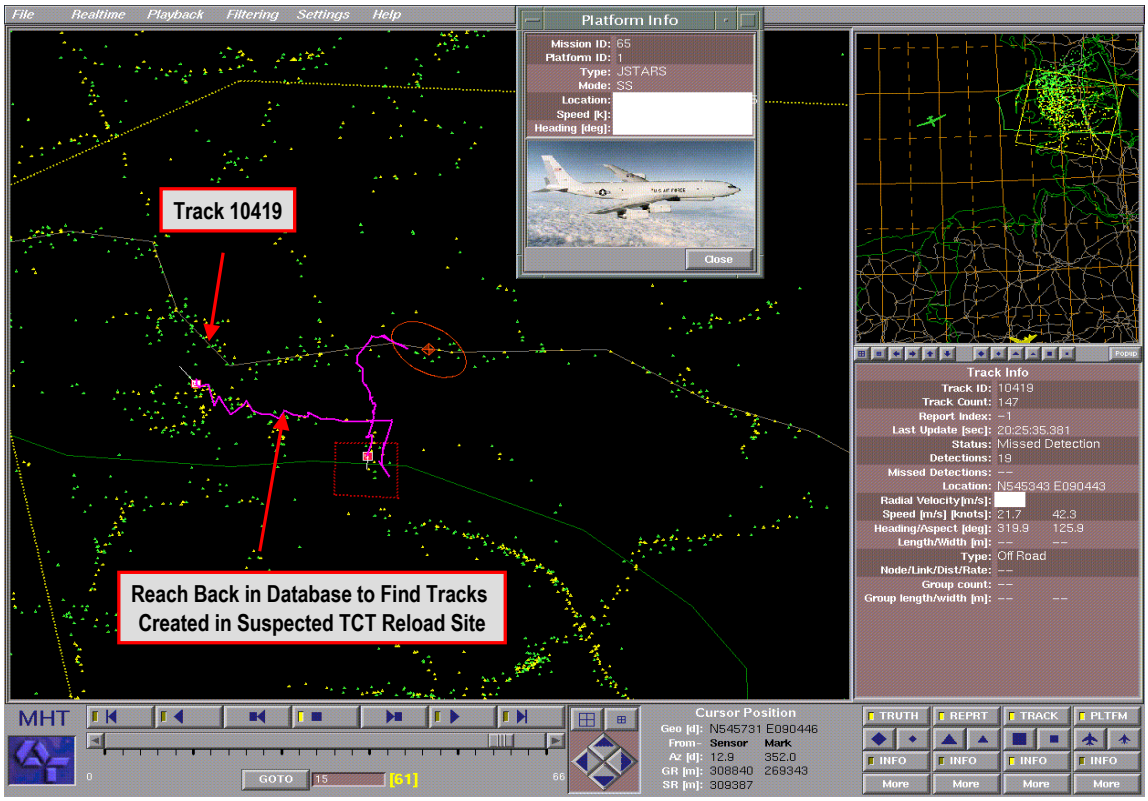

Figure 7: Example of Exploited MTI Data.

The risks associated with MRM were not completely avoided. Although the TBM units operate towards the rear it is necessary for JTMDC training that civilian or background traffic be represented in the TBM area of operations. Although JTLS can represent civilians and refugee movements, it was decided that civilian traffic would not be scripted for this exercise.

Future research will investigate the RPRFOM (real-time platform reference FOM) and HLA gateway as a means to allow position reporting to JTLS rather than having to duplicate objects in the battlespace.

NATO Alliance Ground Surveillance (AGS) Capability Testbed (NACT)

In November of 1995 the Council of National Armaments Directors (CNAD) decided that NATO should acquire an AGS capability based on NATO-owned-and-operated core capabilities supplemented by interoperable national assets. The NACT was then established with the support of NC3A, SHAPE and six nations and provides the NATO nations with a unique international testbed for research and development of interoperable AGS systems in support of NATO AGS requirements.

The NACT consists of NATO and nationally supplied hardware and software that allows systems to be interconnected for the purposes of enhancing development efforts, performing experiments, providing demonstrations and participating in exercises. The NACT consists of two local-area networks (LAN), a simulation LAN using the Distributed Interaction Simulation (DIS) protocol and an exploitation LAN in which data is passed in NATO EX and Link-16 message formats (see Figure 8).

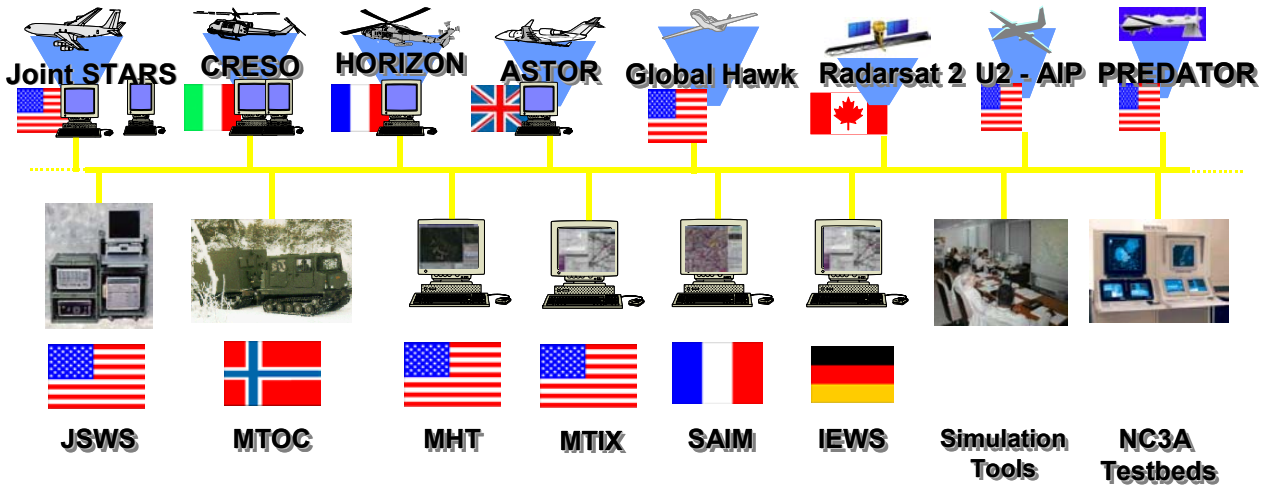

Figure 8: NATO Alliance Ground Surveillance (AGS) Capability Testbed.

The NACT is a unique facility in that it is a true international interoperability testbed allowing currently seven participating nations to exchange ISR data. It is difficult for nations to develop inter-service testbeds, and developing international facilities is even more difficult. The importance of such testbeds for building coalition military capability was described by Sir Robert Walmsley, chief of defence procurement and chief executive of the UK Defence Procurement Agency: "Interoperability is a key determinant of any coalition's capability. The increasingly important role of information in military operations … is hugely more important today in the thinner battlefield. This testbed activity is essential (absolutely sine qua non) to interoperability."[4]

Achieving Interoperability

The key element in achieving interoperability across this diverse collection of AGS systems is the use of the NATO EX message format[5]. The precursor to the Common Ground Moving Target Indicator (CGMTI) message[6], NATO EX consists of a header and three segments (MTI, SAR and ESM). By reformatting data at the ground station, information from all of the sensor and exploitation systems can be shared without having to consider proprietary datalink issues.

CAESAR Project

The Coalition Aerial Surveillance and Reconnaissance (CAESAR) project was established as a seven-nation project in January 2001 and named the US's Advanced Technology Concept Demonstration (ACTD) of the Year.

Member nations include Canada, France, Germany, Italy, Norway, the United Kingdom and the United States. For Cannon Cloud, a limited set of CAESAR participants will support the conventional counter-force mission.

[4] 'Roadblocks to Interoperability Frustrate Coalition Communicators', Signal, November 2000, p 41.

[5] NC3A Technical Note 732, 'Formats for the Representation of Alliance Ground Surveillance (AGS) Pre-Exploitation Data Types', P.J. Lenk, October 1998 (NATO Unclassified).

[6] See also STANAG 4607 (CGMTI) draft version 1.01d5a, 27 April 2001.

A true coalition effort, CAESAR has a central objective of developing the operational concepts, tactics, techniques and procedures, and technology that will enhance the interoperability of existing and planned coalition ground surveillance assets. Based on simulated experiments and live-fly exercises, the project provides a vehicle to develop, demonstrate, evaluate, and transfer into existing hardware the ability to:

- Disseminate Ground Moving Target Indicator (GMTI) and Synthetic Aperture Radar (SAR) data and exploitation products from multiple platforms and exploitation capabilities in a common format;
- Provide enhanced exploitation of GMTI and SAR data for improved correlation, location accuracy, tracking continuity, and tracking accuracy;
- Archive, search, and retrieve SAR and GMTI data using a distributed database architecture;
- Produce data or displays to support the development of a Common Operational Ground Picture and/or Joint Tactical Ground Picture;
- Assist in evaluating the effectiveness of multiple assets in supporting Requests for Information and their impact on Mission Tasking and Planning;
- Migrate GMTI and SAR exploitation to an Internet-browser-based, hardware-independent solution;
- Provide more accurate representations of simulated ground movement to support development and training.

In addition, the project provides the context for developing, implementing, evaluating, and refining the operational processes required to effectively task, plan, operate, and exploit coalition ground surveillance assets to support Intelligence Preparation of the Battlefield (IPB), Indications & Warning (I&W), Situation Awareness (SA), and Targeting.

THE WAY AHEAD

The results of the TMD portion of CC02 will be assessed in a number of ways. ISR management, the CCIRM (collection and coordination of intelligence requirements management) process and the effectiveness of locating critical elements or TBM infrastructure will comprise the top-level assessment for a 'lessons learned' report to the NATO Modeling and Simulation Group (NMSG 006) on Extended Air Defence C2 Interoperability.

CAESAR Project

The CAESAR project will evaluate a questionnaire that is to be given to various operators for subjective assessment of the operational value of interoperable AGS assets in support of time-sensitive targeting. The questionnaire itself will be revised and updated in preparation for possible CAESAR participation in Roving Sands 2003.

More detailed assessment of technical interoperability will be performed under the CAESAR project with network bandwidth metrics, message format compliance and possible simulation anomalies.

TNO-FEL

The successful demonstration of linking exercise simulations using HLA provides an opportunity for future participation of the Dutch armed forces in larger NATO exercises that include TMD operations.

NATO Perspective

The creation of the NATO-Russia Council with its emphasis on TMD and the progress of the NATO TMD Feasibility Study should provide greater demand for TMD simulations.

NC3A CCSD HLA Lab Integration Project

The Command and Control Systems Division has begun work in the development of a federation of division laboratories and testbeds based on HLA. During the next year it is anticipated that the TMD simulations integrated for CC02 will be expanded to include the C2 lab (ICC), and the electronic warfare (EW) and NATO Airborne Early Warning (NAEW) testbeds.

Semi-Automated Forces

The nature of the TBM threat lends itself to scripted simulation. Fire battery and infrastructure movements must be planned well in advance with launch and hide sites pre-surveyed to accommodate the large, cumbersome vehicles. Modern manoeuvre warfare as a general rule is dynamic and in order for the NC3A and the CAESAR project to support Article V high-intensity combat, an alternative to scripted scenario generation is required.

In November of 2001 the NC3A received the OneSAF simulation[7], a highly detailed code that contains automated behaviours based on military doctrine. The complexity of OneSAF requires multiple processors in order to support AGS operations; to this end a cluster PC has been assembled in the NACT to support battalion-level combat simulation.

The absence of TBM units in OneSAF has prompted the Agency to request JointSAF. This derivative of OneSAF has both TBM units as well as autonomous background traffic. Operating JointSAF would allow NC3A to achieve the next step in TMD training capability: linking dynamic simulated attack assets with the ICC Joint Targeting System, due for release in December 2002. JointSAF could also be a common link with the US Joint Forces Command (JFCOM) Joint Training and Simulation Center (JTASC), allowing greater participation in future simulation experiments.

Distributed Simulation

The logistics of transplanting the NACT equipment entail a substantial cost to the Branch; research into performing distributed simulation AGS experiments using the Combined Federated Battle Lab Network (CFBLNet) is under way. A network of high-capacity secure communications lines, CFBLNet may provide a more cost-effective way of conducting experiments. It is not used for operational applications.

Joint Distributed Engineering Plant (JDEP)

The Joint Distributed Engineering Plant concept was briefed to the NC3A in December 2001 and subsequent high-level discussions with US officials indicated that the NC3A is considered to be a candidate node on this advanced network. The CAESAR project also has voiced interest in distributed simulation as a means to provide additional program experiments at substantially lower cost.

[7] Operational Testbed (OTB) International Release, version 1.0.

Synthetic Environment

Each of the AGS systems described here, be it a sensor simulation or an exploitation workstation, is a powerful geographic information system (GIS) that requires accurate and consistent data to operate and, perhaps more importantly, to interoperate. Digital mapping data is provided to the Agency through our SHAPE sponsor but given its purpose of supporting a single customer (the NATO command structure), interoperability is not an issue.

The coalition factor of AGS operations in the NACT requires that GIS data be provided too many systems some of which may not be compatible with the NATO GIS. An alternative is for the NACT to provide conversion to a common GIS standard.

The Open GIS Consortium (OGC) is currently under evaluation but an alternative is to employ the Synthetic Environment Data Repository Interchange Specification (SEDRIS), which has the advantage that it includes atmospheric information. Recently NATO Land Group 8 emphasized the value of SEDRIS (as well as HLA) as a means to achieve simulation interoperability.[8]

A drawback to the use of OneSAF/JointSAF is the difficulty and/or expense of creating terrain databases (compact terrain databases or ctdb). SEDRIS provides a capability to build ctdb files using SEDRIS Transmittal Format (STF).

SEDRIS associates (e.g. TNO, Northrop Grumman IT) have provided tools for processing the digital terrain elevation data (DTED) and vector map (VMAP) information necessary for simulating the robust land environment required for AGS. Work continues in this area and appears promising.

[8] Minutes from Mr. Gene Weihagen, Chair, NATO Land Group 8 on Training Simulation Interoperability, 31 January 2002.

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NC3A Simulation Support for Theatre Missile Defense Operations in NATO Exercise Cannon Cloud 2002 (CC02)

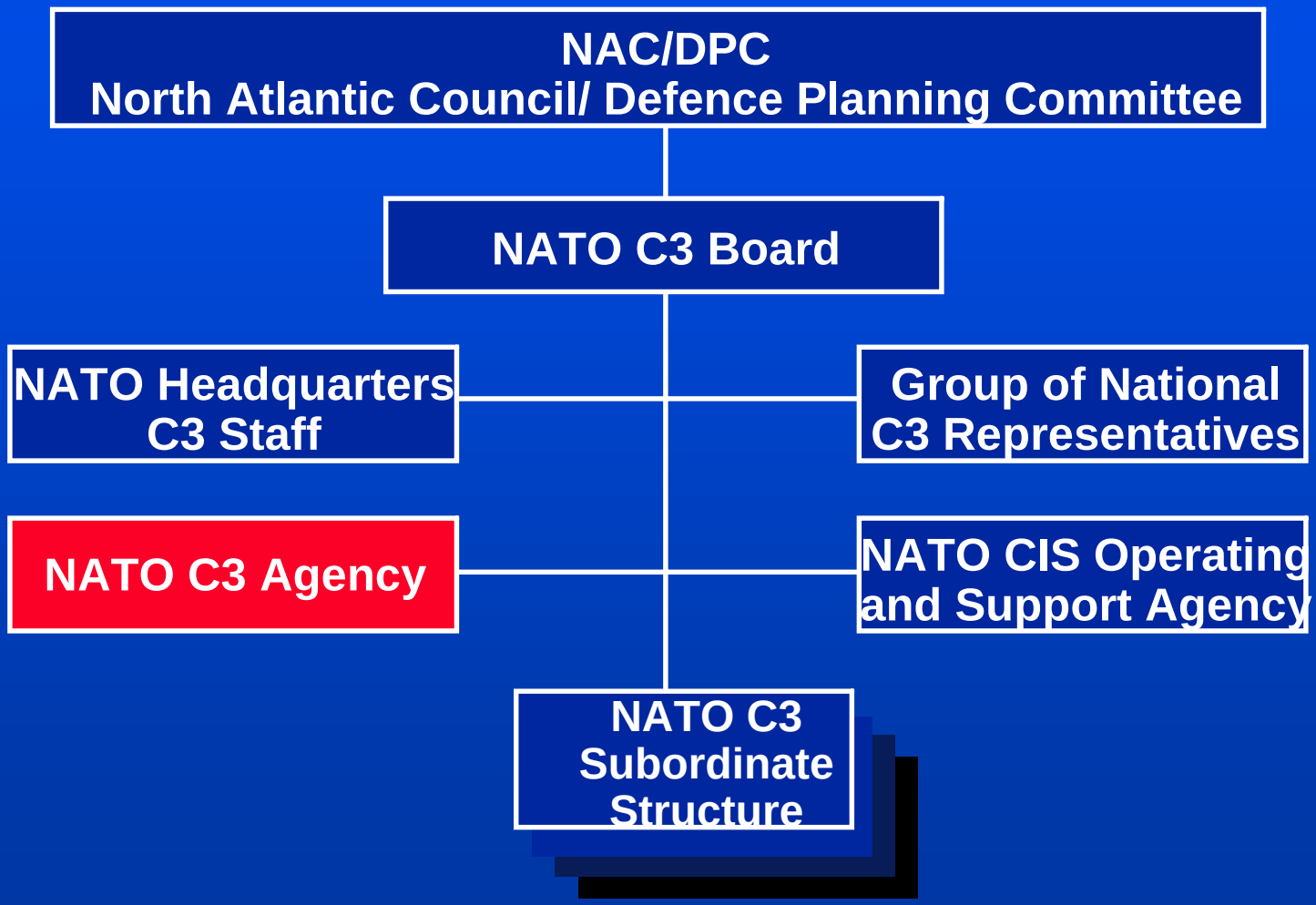
David F Taylor

C2 Concepts and Architecture Branch
Command and Control Systems Division

Agenda

- Introduction to NATO C3 Agency
- NATO Exercise Cannon Cloud 2002 (CC02)
- NATO Theatre Missile Defense in CC02
- Modeling and Simulation for CC02
- Question and Answer Session

NATO C3 ORGANISATION



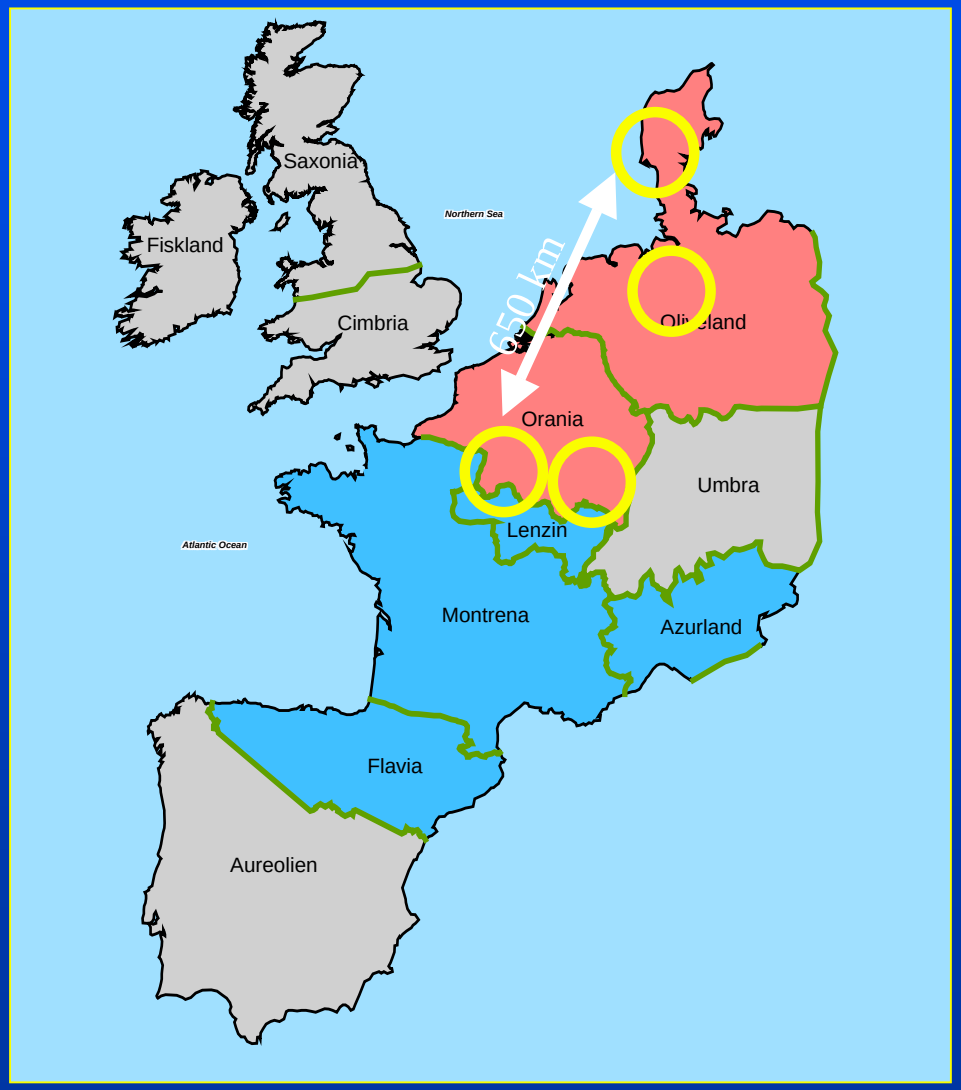
NC3A DIRECTORATE

- EXECUTIVE STAFF
- INTEGRATED PROGRAMME STAFF
- **C2 SYSTEMS DIVISION**
  - **C2 Concepts and Architecture Branch (CCB)**
    - Concepts and architectures development for C2
  - **C2 Systems Design Branch (CSB)**
    - C2 systems design and C2 systems interoperability
  - **C2 Technology Branch (CTB)**
    - C2 Warfare and C2 protection techniques and technologies
  - **Sensors and Surveillance Branch (SSB)**
    - Sensor & surveillance concepts, techniques and technologies
- COMM & INFO SYSTEMS DIVISION
- OPS RESEARCH & FUNCTIONAL SERVICES DIVISION
- ACQUISITION DIVISION
- RESOURCES DIVISION
  - **Theatre Missile Defence Study Management Team (TMD - SMT)**
    - Management of the TMD Feasibility Studies

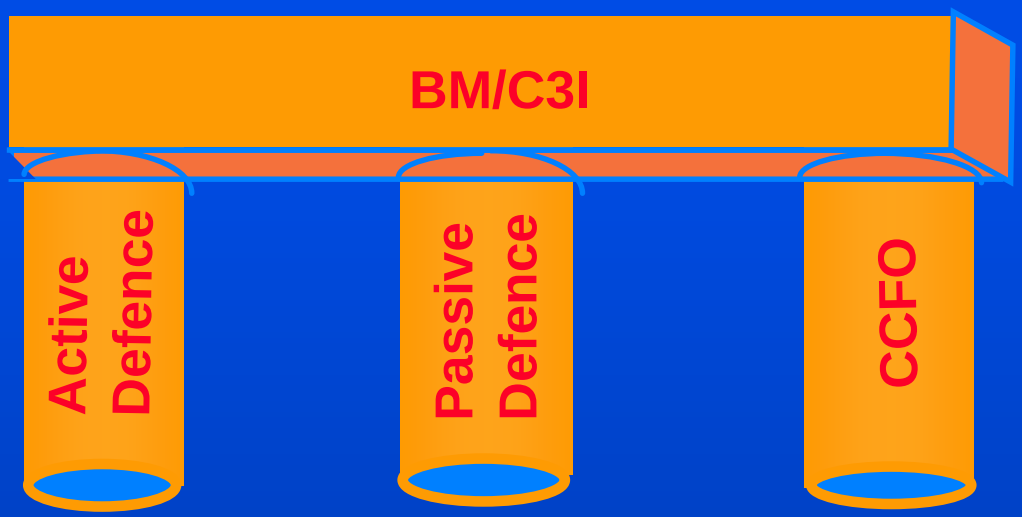
- Joint C2 and ISR Concepts & Architectures
- Extended Integrated Joint Defence
- Requirements Capture and Performance Analysis
- C2 Modelling and Simulation

NATO Exercise Cannon Cloud 2002 (CC02) and Constructive Optic Windmill (COW)

Exercise Regions

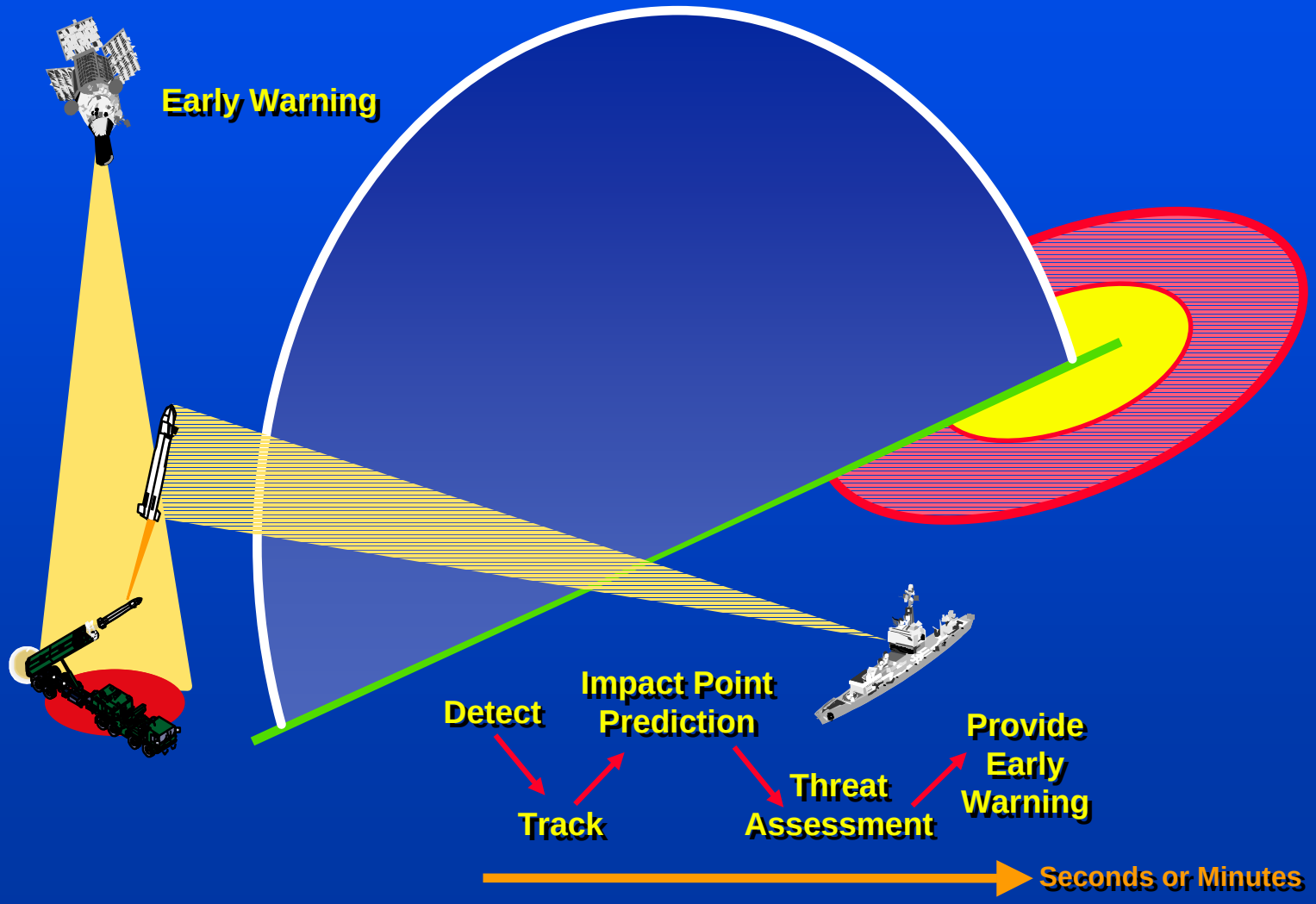


Three Pillars of Theatre Missile Defence

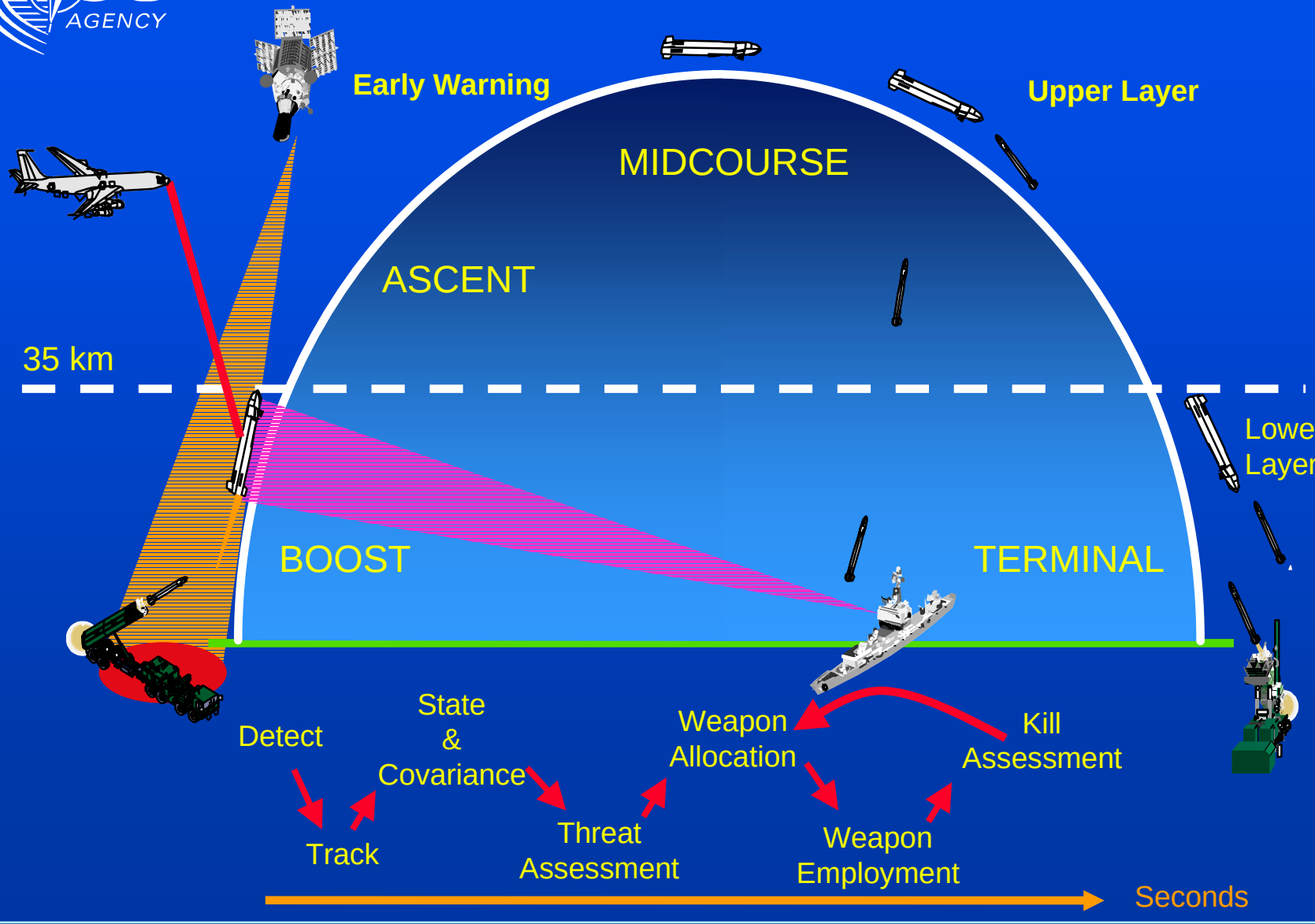


- Battle Management / Command, Control, Communications and Intelligence (BMC3I)
- Active Defence
- Passive Defence
- Conventional Counter Force

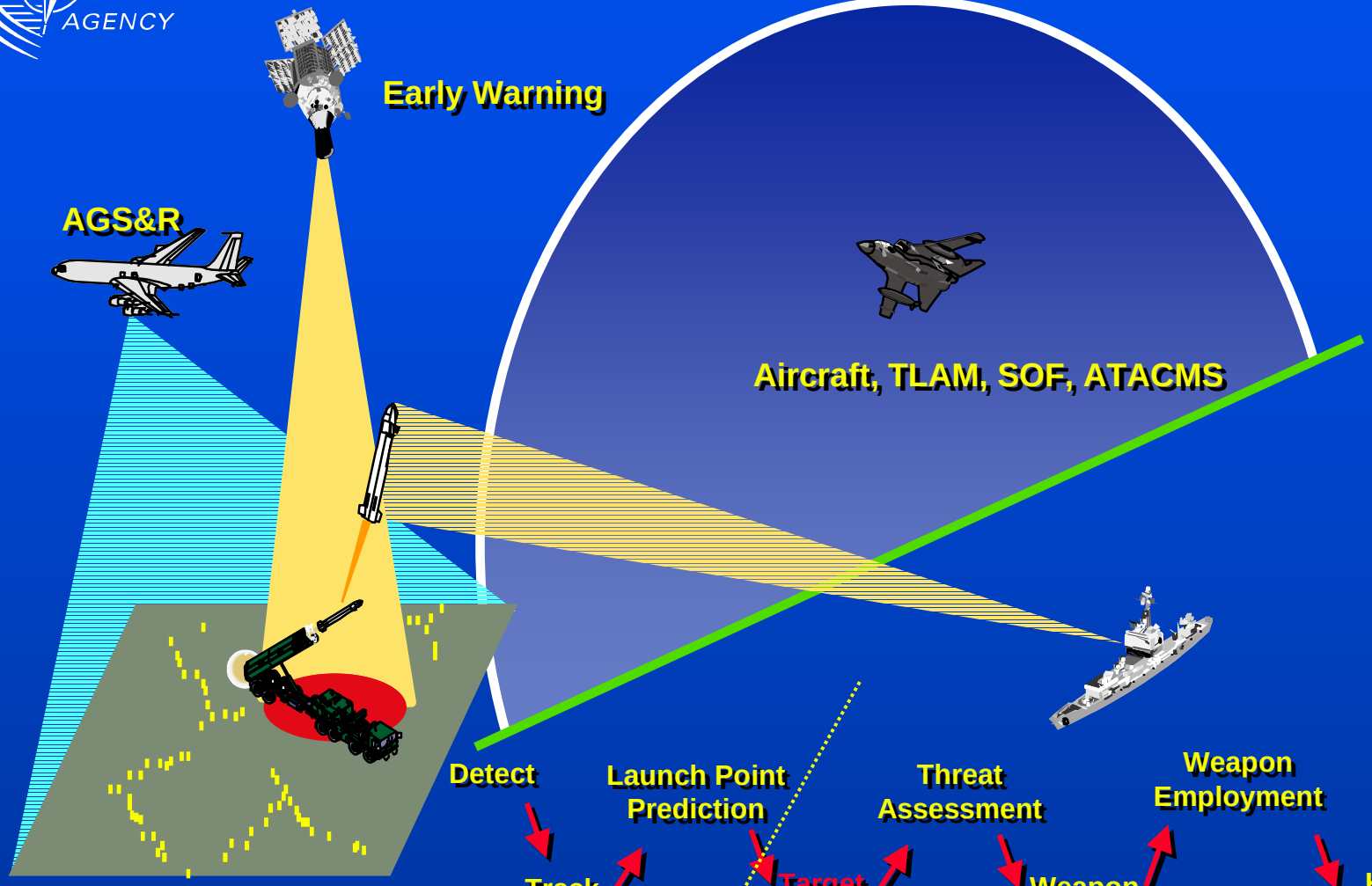
Passive Defence



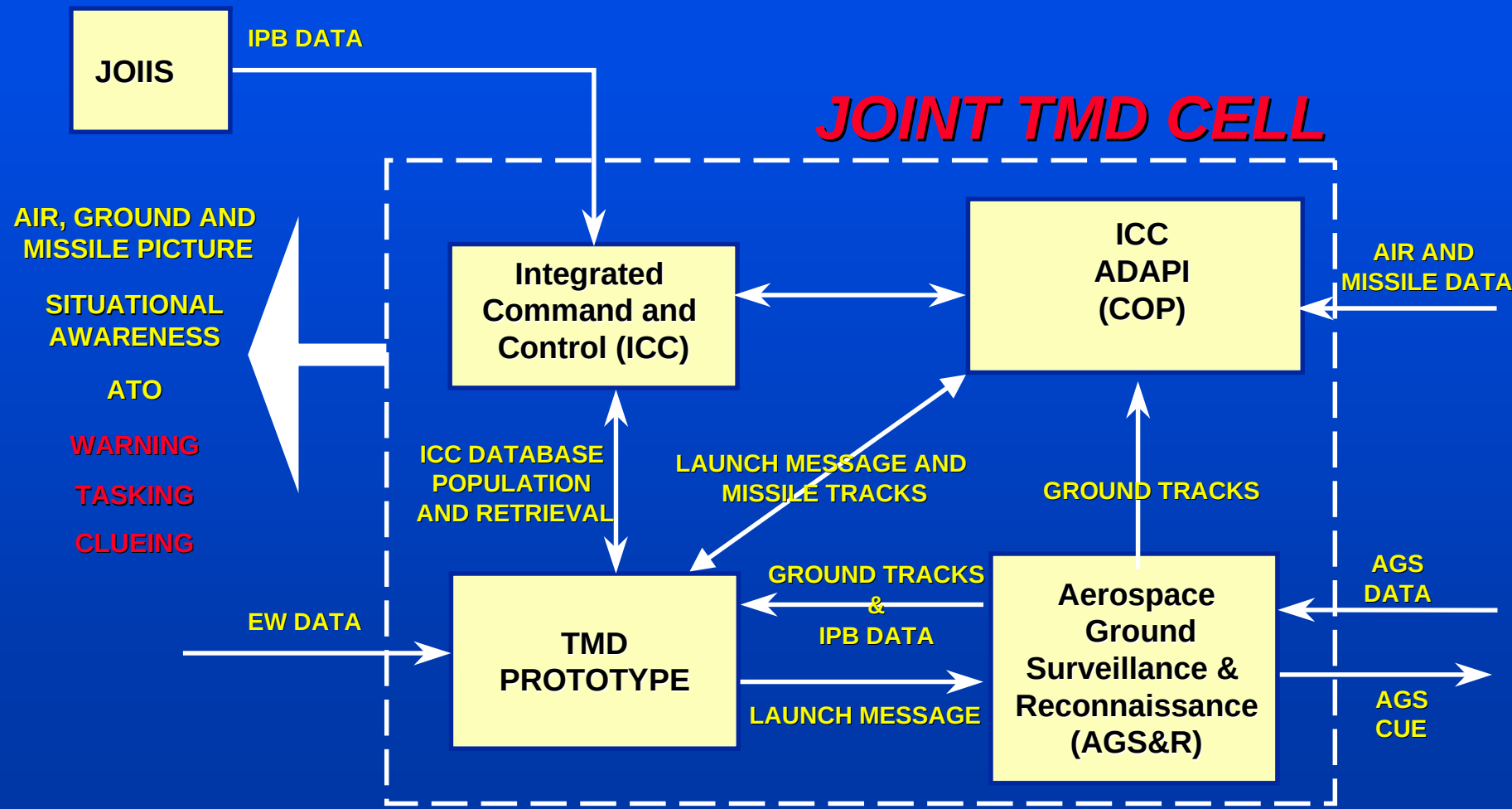
ACTIVE DEFENCE



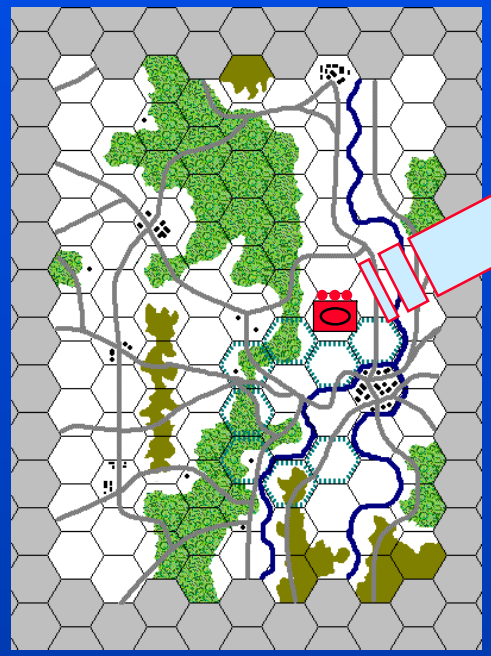
CCFO

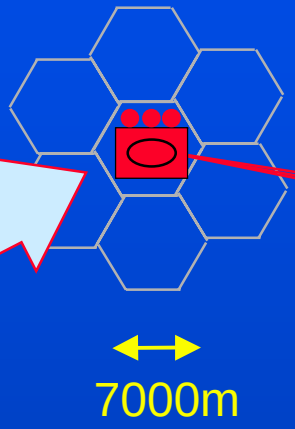


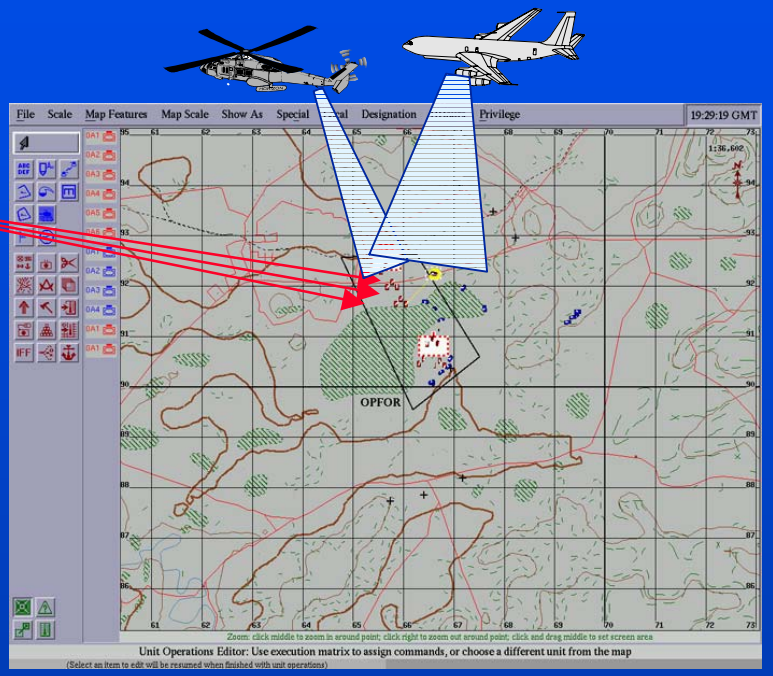
SYSTEMS INTEGRATION FOR NATO TMD C2



Cannon Cloud 02
The Aggregation Problem





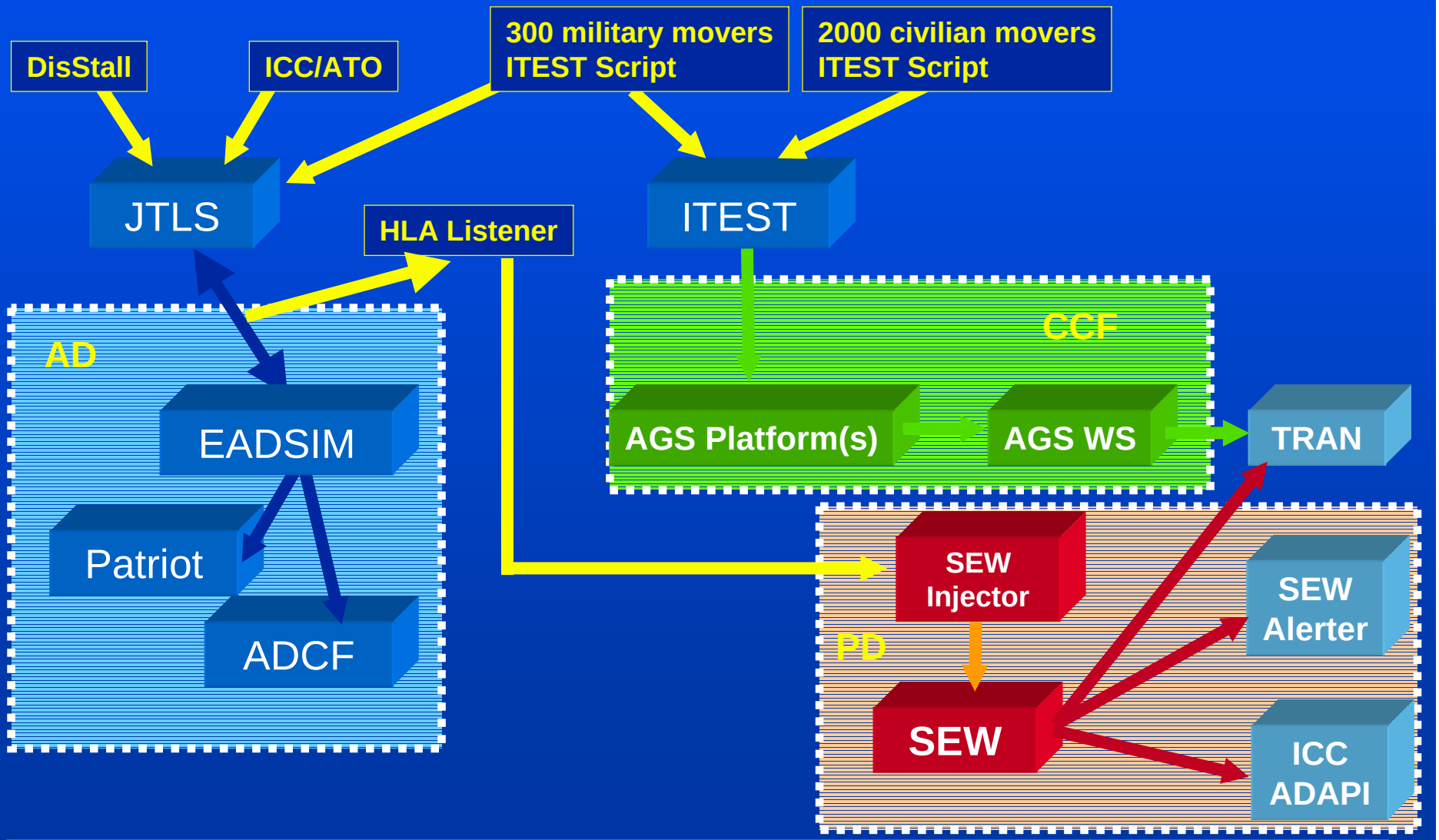


Joint Theatre Level Simulation (JTLS)

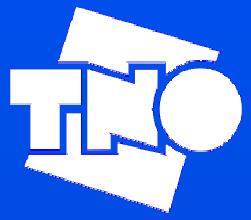
Categories of Errors
- Time
- Location
- Velocity
- Road registration
- Features

Operational Testbed (OneSAF)

CC02/COW TMD Simulation Architecture

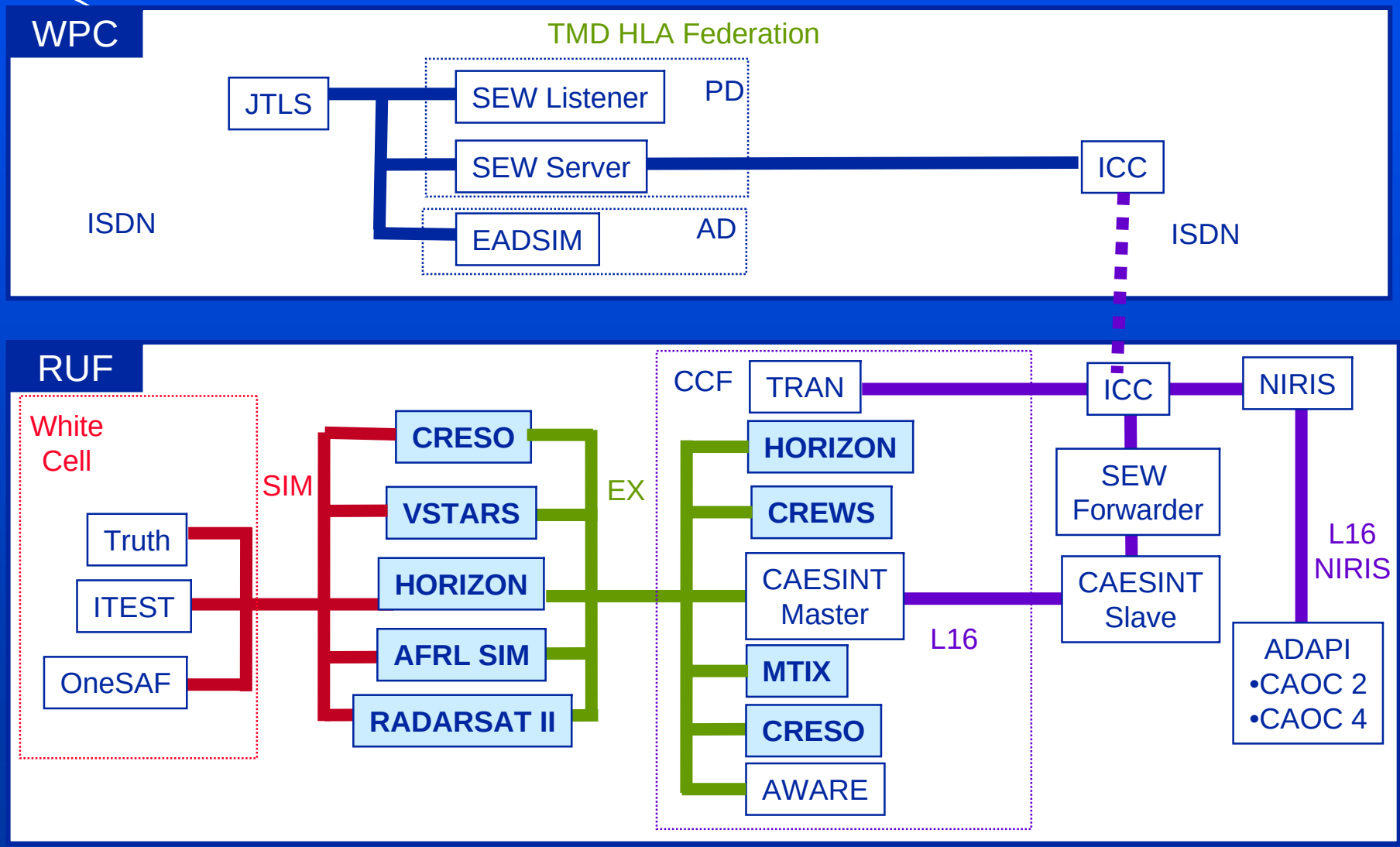


JTLS-EADSIM Federation Capability



JTLS (NC3A)		EADSIM (TNO-FEL)
	Fire Missile Order Interaction →	create a TBM launcher icon
Flight-path of TBM is ghosted and displayed by JTLS	TBM Position ←	Flight-path of TBM is computed and displayed by EADSIM
•After destruction of TBM by EADSIM, (ghosted) TBM track disappears and no ground impact •If EADSIM fails to intercept a TBM fired by JTLS (e.g. because it is out of the range of the Patriots), subsequent impact of the TBM should be assessed by JTLS	Status ←	EADSIM intercepts and destroys TBM fired by JTLS

CC02 Top Level Data Flow



Conclusion

- NC3A simulation support of Exercise Cannon Cloud 2002 successfully integrated entity-level simulation into an operational level CAX and into NATO C2 systems to support Theatre Missile Defense
  - Active defense using EADSIM
  - ~3000 Ground movers
  - TBM infrastructure movements synchronised with MIL/MEL and remote missile launch warning from US
  - Robust AGS simulations including SAR simulations
  - Advanced MTI exploitation systems integrated into JTMDC
- TNO-developed HLA interface to JTLS allowed Active Defense to be conducted under the Dutch-German Constructive Optic Windmill exercise
- Demonstrate benefits of interoperable AGS systems in support of CCFO and overall command situation awareness
- The Way Ahead
  - HLA Gateway with RPRFOM to link DIS simulations to larger federation
  - semi-automated forces for the simulation of combat operations
  - Synthetic environment for standardised GIS data

Questions?